Discussion
The results presented from the plants belonging to different families characterize the natural occurrence of growth inhibitors and accelerators. They have been isolated and identified on the basis of thin layer, column and counter current chromatography with different solvent systems, use of specific reagents and physical measurements viz., mass spectroscopy (MS), infra-red (IR) spectroscopy, nuclear magnetic resonance (NMR) spectroscopy and specific bioassays. The inhibitors, coumarin, abscisic acid and fatty acids have been reported in the thesis and also their biological role in the plant are predicted. The occurrence of coumarins in *Camellia sinensis* has already been reported (Ray, 1988). The inhibitory activity of fatty acid was reported earlier by Buller *et al.* (1976) and Saha (1976). The question now arises as to what significant role these inhibitors are to play on the biology of the plant. It is now an accepted principle that all physiological processes are controlled by the interaction of growth promoters and inhibitors. In this context, the detection of different classes of inhibitors from plants are of particular significance. Isolation and detection of several plant hormones have been reported extensively but comparatively less attempts have been made to characterize the natural occurrence of inhibiting compounds. The favourable environmental conditions are likely to promote large growth by the stimulators present which need some sort of balancing in the growth potential of the plants and the natural occurrence of inhibitors is to be viewed in this light. This philosophy could be possibly strengthened further by the detection of some unknown growth inhibitors reported in this thesis.

Darjeeling tea is famous for its flavour character. The flavour of this tea is the combined effect of non-volatile solids extracted from the tea leaves during brewing and the volatile fraction of tea leaves dry extract. With a view to improve the flavour character, the present investigator made a detail analysis of flavour constituents of Darjeeling black tea which is
Tea exhibits an alternate growth phase commonly known as flush period and bunji period (dormant period). Several hypotheses have been put forward to account for this alternate phase of growth and dormancy. According to one such hypothesis (Barua, 1969b) synthesis of growth factors takes place in the roots when they grow actively and the shoots remain dormant. When sufficient concentration of these substances are built up in the roots they move up to the shoots to promote a new flush of growth. Meanwhile, the roots get depleted of growth factors, on account of which their supply to the top is interrupted and the shoots become dormant and the cycle thus continues. Based on this hypothesis, the present investigator examined the presence of growth regulators in tea leaves in both growth and dormant period.

In order to ascertain the reason behind the alternate growth and dormancy of the tea plant, the leaves of the plant during the growth and the dormant period were analysed by the present investigator. It has been observed that the tea leaves collected during the growth or the flush period yield IAA, IBA and gibberellic acid A3, A4, A7 and A13 whereas, in the leaves collected during dormant period, a mixture of fatty acids, scopoletin, IAA, ABA were present.

It is interesting to note the presence of IAA along with other growth inhibitors in the leaves collected during dormant period. Further, during the dormant period formation of fatty acids also occurs which may act as an inhibitor. Mandava and Mitchell (1972), have noted that fatty acids in cotton pollen act as promoters. But, Buller et al. (1976) have reported the inhibitory activity of fatty acids in oat. Since fatty acids were detected only from the dormant period leaves and they are absent in the leaves collected during the flush period, it may be
concluded that fatty acids in this case may act as growth inhibitors.

The formation of fatty acids along with complete disappearance of gibberellins (found in the growth period) in the dormant period is an interesting feature to take note of. The question arises, whether, gibberellins through some reactions are converted to fatty acids or else could be their fate after the end of flush period.

The presence of IAA in both dormant and growth period leaves appears to be very interesting although the amount of IAA in dormant period leaf is much higher than those of growth period. IAA is probably present in supra-optimal concentration which results in growth suppression of leaf. During growth period some of this IAA is reduced. This may occur either by conjugation with sugar or by the effect of plant pathogen Corynebacterium fascians which is known to reduce IAA to tryptophol (Kemp, 1978).

Gibberellins, IAA and IBA which is present in growth period leaf are presumably responsible for better growth and all these stimulators disappear during dormancy. This may happen due to transformation of these growth promoting substances to other compounds which has no or little stimulatory effect. Further, it may be mentioned that this is the first report of the natural occurrence of IBA.

Besides the detection and characterization of the above compounds from tea leaves, an angular furocoumarin was also isolated. This compound, 4-hydroxy, 2'-methoxy angular furocoumarin, was found to be a structurally new compound. It has been fully characterized and was found inhibitory to growth in wheat coleoptile bioassay test (Tables: 11-13). There are
earlier reports that coumarins are generally growth inhibitors. Some coumarins and their
derivatives viz., aesculetin and daphnetin have inhibiting effects (Veldstra and Havinga, 1945).
Coumarins are important components of the growth regulating system since it shows significant
interaction with auxins and cytokinins.

In addition to the study of biologically active constituents in tea plants, a detailed study of
the aroma composition of Darjeeling tea was also undertaken. As mentioned earlier, studies of
Camellia sinensis tea aroma have been reported by various authors (Straten and Maarse, 1989).
The Darjeeling tea steam distillation extract (SDE) and three types of brewed black tea extracts
are examined by gas chromatography (GC). The identified compounds and relative quantities of
each compound, as calculated by the peak area, was ascertained. Thirty eight compounds were
identified from the Darjeeling brewed extract and fifty two compounds from the Darjeeling
SDE. The Darjeeling brewed extract included higher amounts of acids, aromatic alcohols and
monoterpeneadiol and lower amounts of monoterpen alcohol than the SDE. The main
components of the SDE were geraniol, linalool, linalool oxides II, I and IV, and methyl
salicylate, while the main components in the brewed extract were more complicated, including
linalool oxide II, geraniol, linalool oxide IV, trans-geranic acid, linalool, (E)-2-hexenoic acid,
benzyl alcohol, hexanoic acid, linalool oxide I, 2-phenylethanol, (Z)-3-hexenoic acid and 2,6-
dimethyl-3,7-octadiene-2,6-diol, in order of quantity. Terpene alcohols such as geraniol and
linalool, which have been reported previously as the main Darjeeling tea flavour, decreased in
amount in the brewed extract. These terpene alcohols appeared to be formed by the SDE
process from the precursors, glycosidic derivatives, namely primeverosides (Guo et al., 1994;
Moon et al., 1994). 2,6-Dimethyl-3,7-octadiene-2,6-diol and the dehydration compound, 3,7-
dimethyl-1,5,7-octatrien-3-ol are characteristic factors in Darjeeling teas, made from tea leaves.
infested with green flies (*Emposca flavescens*). These two compounds appeared to be related to Darjeeling's characteristic muscat flavour. It has been reported that the SDE extract of Taiwanese Pom Fon oolong tea, also made from tea leaves injured with green flies, contained 10.14% 3,7-dimethyl-1,5,7-octatrien-3-ol (Takami *et al.*, 1990). 2,6-Dimethyl-3,7-octadiene-2,6-diol seemed to be formed by an abnormal biosynthesis pathway caused by infestation of green flies.

From the stem of *Tripsacum laxum* a number of growth regulators viz., n-triacontanol, indole-3-acetic acid and gibberellins A₃, A₄ and A₇ were detected and fully characterized using various physico-chemical methods. The growth regulators in *T.laxum* may play an important role in soil enrichment. Moreover, it may be presumed that growing of this plant for soil rehabilitation not only maintains the humus balance but also enriches the soil with growth regulators.

A very promising natural occurrence of inhibitors is the isolation of cucurbitacins in a large number of plants. This has played a significant role in several aspects of growth and metabolic reactions. This inhibitory compound was mainly isolated from the plants belonging to the family Cucurbitaceae but its occurrence has been reported in many other families e.g. Euphorbiaceae (Saha *et al.*, 1981). This would suggest that growth or metabolic inhibition is of universal occurrence through some form of inhibitors.

The presence of cucurbitacins has been reported from large number of plants belonging to the family Cucurbitaceae (Guha and Sen, 1975) which is also known to show the occurrence of natural gibberellins. This would presumably be related to functions of different gibberellins and
their interaction with cucurbitacins. It would be of interest to know whether there is any biogenic and biochemical reactions between gibberellins and cucurbitacins. One might speculate that each gibberellin action is neutralised or inhibited by a particular cucurbitacin. Guha (1974) has already investigated these aspects and further work would be necessary to throw light on the importance of inhibitors in different physiological and biochemical processes of plants. It has already been mentioned from physical and chemical evidences that the cucurbitacin isolated from L.cylindrica by the present investigator is a new one and its structure was established.

The problem now remains to study the physiological and biochemical role in several inhibiting processes regulated by cucurbitacins. In view of the conflicting role gibberellin plays in several reactions and interaction with the naturally occurring ABA or cytokinin, it seems pertinent to speculate whether cucurbitacins acts when other inhibitors fail.

The natural occurrence of cucurbitacins have thus opened a promising field of study in the entire biology of a plant depending on growth stimulation and inhibition. Our future efforts should be directed towards this aspect to add new knowledge to the interaction of growth promoters and inhibitors.

As mentioned in the previous sections a mangrove plant, Bruguiera gymnorrhiza was used for study and a new cytokinin was isolated from the leaves. The structure of this compound was established on the basis of physical studies viz., IR, NMR and MS. The problem is to ascertain the significance in the peculiarities in growing habit of mangrove plants. The occurrence of GA3, GA1 and GA7 have been reported previously (Ganguly and Sircar, 1974) and they are
possibly associated with several characteristics of the plant. Recently, two new cytokinins were isolated from marine organisms (Farooqui et al., 1990). The presence of cytokinin in marine organisms is rather unusual. It would be of interest to find out the role of cytokinin in marine organisms.